

Results of the Tophane Area GPR Surveys, Bursa, Turkey

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*“Civilization exists by geological consent,
subject to change without notice.”*

—attributed to U.S. historian
Will Durant (1885–1981)
by Robert Byrne (1988)

In turning to archaeology to tell the story of abandoned cities, destroyed buildings, and extinct civilizations, one can understand the wisdom of Will Durant’s epigram. Geological “agents,” namely several earthquakes, played a role in Bursa’s continuing urban evolution. The most devastating of these occurred in 1855, leveling most of the buildings dating to the Roman, Byzantine, and early Ottoman periods. Following the 1855 disaster, new structures were erected and those still standing were restored, but given the lax ethics governing restoration in the mid-nineteenth century, little attempt was made to conserve original details. As a result, the city one sees today reflects the influence of its governor when the 1855 earthquake hit almost as much as it does the influence of Orhan I (r. 1326–1361), the second ruler of the nascent Ottoman empire.¹

Before it was conquered by the Ottomans in 1326, the Byzantine city of Prousa (as Bursa was previously known) was mainly confined within a citadel that was situated over a promontory. The citadel encompassed

a palace as well as four Byzantine monastic establishments: the Prodromos, Hexapytergos, Kabalos, and the *megale mone*, or grand monastery. When the Ottomans took control, they converted two monastery buildings into mausolea for the founders of the Ottoman state, restored the fortification walls and palace, created new residential areas, and constructed new buildings.² The Ottomans made the citadel the focus for the accommodation of the city’s visual past, and especially of its most recent Byzantine layer. Ultimately, the Ottomans preserved local forms with past referents as part of their architectural idiom—both in new construction and in the revival of ancient buildings. A distinct local urban-visual language thus emerged, an initial step in the Ottomanization of Prousa.³

The historian Colin Imber has called the fourteenth century a “black hole” for students of the formation of the Ottoman state in Bursa, because of the overall paucity of textual evidence.⁴ And, indeed, no recent studies on the early Ottoman state look beyond the scarce written record in reconstructing the history of Bursa. By probing structures—and their status as

1 W. B. Denny, “Quotations in and out of Context: Ottoman Turkish Art and European Orientalist Painting,” *Muqarnas* 10 (1993): 219–30, esp. 225.

2 R. Janin, *Les églises et les monastères des grands centres byzantins* (Paris, 1975), 174–75.

3 As I have discussed in “Prousa/Bursa, A City within the City: Chorography, Conversion, and Choreography,” *BMGS* 35, no. 1 (2011): 45–69.

4 C. Imber, “The Legend of Osman Gazi,” in *The Ottoman Empire, 1300–1389*, ed. E. Zachariadou (Rethymnon, 1993), 75.



FIG. 1. Tophane Area GPR Survey, Bursa (Base map: Google Earth Map, © 2014, CNES, Astrium)

cultural artifacts—scholars can offer an alternative way of assessing the complexities of this period or, for that matter, of any period, helping move beyond a consideration solely of the textual record.⁵

To demystify the founding of Bursa, with a focus on the first Ottoman capital and its Byzantine substrata, this fieldwork report summarizes the results of a geo-archaeological survey using ground-penetrating radar (GPR) in pursuit of buried architectural features in Bursa's old city, which was carried out from 9 June to 22 June 2009; the results were analyzed from 22 June to 10 July of the same year. The results consist, first, of thoughts on strategies for the archaeological excavations in 2015. Second, they introduce the design principles for a prospective archaeological park and cultural heritage management project in the area.

5 S. Çağaptay, "Frontierscape: Reconsidering Bithynian Structures and Their Builders on the Byzantine-Ottoman Cusp," *Muqarnas* 28 (2011): 156–91.

The GPR survey focused on the northern tip of the citadel because this part contains two crucial loci. First is Tophane Park (fig. 1), which includes the tombs (mausolea) of the Ottoman founders, an area originally occupied by the Byzantine monastery of Prodromos.⁶ The second location is the military guesthouse, which corresponds exactly with the area once filled by the palace established by the Byzantines and reused by the Ottomans.⁷ In this survey, the primary author identi-

6 See eadem, "Visualizing the Cultural Transition in Bithynia (1300–1402): Architecture, Landscape and Urbanism" (Ph.D. diss., University of Illinois at Urbana-Champaign, 2007) and "Prousa/Bursa," 61 n. 58, for an analysis of Byzantine sources for the Monastery of Prodromos in Prousa.

7 The cadastral map drawn in 1862, immediately after the 1855 earthquake, and current aerial photos show this exact superimposition. For the analysis of the 1862 map and the location of the palace, see Çağaptay, "Visualizing the Cultural Transition"; and eadem, "Prousa/Bursa," 66, nn. 83 and 84 and fig. 1. One must add that in Byzantine architecture, it is common to have residential or palatial

Table 1

Grid	Date of Collection	Grid Description	Number of Profiles	Maximum Dimensions	Profile Separation (mt.)
3	6/9/2009	Grassy area in NW corner of Tophane Park along military wall	33	16 × 10	0.5
4	6/10/2009	Grassy area in NW corner of Tophane Park directly E of Grid 3	32	16 × 18	0.5
5	6/11/2009	The interior of Orhan's Tomb	30	14 × 14	0.5
6	6/12/2009	This is composed of four separate areas, which are the paths around Orhan's Tomb.	53	34 × 33	0.5
7	6/12/2009	School yard	35	17 × 23	0.5
8	6/13/2009	This is a re-collection of a section of Grid 4.	22	11 × 9	0.5
9	6/15/2009	Flagstone surface in front of military office: Building #028	12	5 × 23	0.5
10	6/15/2009	Asphalt driveway leading to the military office	18	10 × 18	0.5
11	6/15/2009	Asphalt road and parking area to the south of the military office	25	12 × 40	0.5
12	6/15/2009	Grassy area in the NW corner of the military zone by the Byzantine wall	20	10 × 10	0.5
13	6/15/2009	Parking lot E of grassy area in the military zone	19	35 × 10	0.5
14	6/16/2009	Asphalt parking lot in front of main military building #004	51	43 × 25	0.5
15	6/16/2009	Residential parking lot on east side of military zone	21	11 × 50	0.5
16	6/17/2009	Military zone tea garden entryway	29	14 × 30	0.5
17	6/18/2009	Tea garden central pathway	37	61 × 18	0.5
18	6/22/2009	Dead end road behind Osman's tomb	6	33 × 3	0.5
19	6/22/2009	Cobblestone courtyard North of Orhan's Tomb	23	11 × 27	0.5

fied all nineteen grids, all but two (taken to set up and test the equipment) listed in Table 1.

The GPR technology allowed for the creation of three-dimensional maps and images of subsurface archaeological materials in areas of interest. This survey technique also helped locate and map deeply buried buildings, as well as survey stratigraphic horizons both for evidence of gardens and to reconcile discontinuities in the archaeological record. The survey brought to light a variety of archaeological curiosities, ranging from areas damaged by fire, to pre- and post-earthquake layers, to several locations with firm architectural phases with superimposed layers. With the survey now completed, the next phases of work are under way: (1) publishing the results; and (2) carrying the research to a new level by opening up, next summer, several trenches to test and determine the stratigraphic layers and evaluate architectural and material findings. These findings encompass the details mentioned by the Byzantine authors and in later travelers' accounts—for example, synthronon, basket capitals, aniconic cross representation, and opus sectile floors. Such details hint that the founders' tombs continued to experience centuries of Byzantine and Ottoman use and refurbishment.⁸

GPR Analysis

The varied ground conditions in the tests included paved asphalt surfaces, cobblestone pathways, flagstones, marble flooring, and maintained grassy areas. Grids of GPR reflection data, composed of many

profiles, were collected at all test areas. The collection of multiple closely spaced profiles allowed for the reflection data to be interpreted both horizontally and vertically. In most cases, horizontal amplitude slices and vertical reflection profiles were produced from these profiles, and both methods of viewing the ground were used in the interpretation. Each data-set is interpreted below in the order the GPR data were acquired.

In the collected data, it is noteworthy that no major architectural phases were identified in and around the tombs; instead, bits and pieces of floor surfaces and several segments of destroyed walls were detected. Interestingly, the areas now occupied by the tea and coffee gardens reveal a highly complex grid that shows evidence of many intersecting walls and entire buildings. The walls tend to range from 0.5 to 2 meters in thickness and create strong reflections in the GPR maps. While several reflections in the amplitude slice maps suggest the appearance of two closely spaced walls, these are actually edges of the same walls. Therefore, next steps will include test trenches near the tombs and more detailed excavations in the garden areas. Reflection profiles collected in the military guesthouse revealed a variety of features, mostly of a residential nature, including a 5 × 5 meter structure in one of the grids and several building remains. Overall, GPR can determine the depth and nature of stratigraphic layers and can also distinguish between modern and ancient.

Reconstructing Historical Memory

As the collected reflection profiles and raw data indicate, Bursa's legacy can be assessed thoroughly only through further archaeological work. Such an undertaking would offer an unprecedented view into the city's late antique, Byzantine, and early Ottoman urban fabric. On the practical side, excavations will bring these layers to light; in conceptual terms, the city's archaeologically recovered urban fabric could well act as an enriched site of historical memory.

Elaborating on this idea of historical memory, its contours are shaped by selective remembering as well as intentional forgetting. As the first capital city of the nascent Ottomans, Bursa's Ottoman/Islamic/Turkish identity has often been emphasized in contemporary Turkish scholarship at the expense of other identities. In works by art and architectural

complexes enclosed within citadels, such as Eskihsar in Bithynia and the Blachernai in Constantinople. For depictions of the palace in Ottoman times, see G. R. Kline, *The Voyage d'Outremer by Bertrandon de la Broquière* (New York and Bern, 1988) 136; and R. Lubenau, *Beschreibung der Reisen des Reinhold Lubenau herausgegeben von W. Sams* (Königsberg, 1930), 176; J. von Hammer, *Umblick auf einer Reise von Constantinopel nach Brussa und von da zurück über Nicäa und Nicomeden* (Pest, 1818), 42; T. Smith, "An Account of the City of Prousa in Bithynia," *Philosophical Transactions of the Royal Society of London* 14 (1684): 432. For the additions and changes to the palace complex, see J.-P. Grélois, *Dr. John Covel, Voyages en Turquie 1675–1677*, *Réalités Byzantines Éditions* 6 (Paris, 1998), 150; J. Spon and G. Wheler, *Voyage d'Italie, de Dalmatie, de Grèce et du Levant fait aux années 1675 et 1676* (The Hague, 1724), 215; K. Baykal, "Bursa'da Saray ve Köşk," in *Milli Saraylar Sempozyumu* (Istanbul, 1984), 21–23.

8 Çagaptay, "Prousa/Bursa," 58–62.

historians, the city has often been portrayed as having a very small and insignificant pre-Ottoman past, as if the Ottomans created the city from scratch. The importance of the “Prousan” past, under the Romans and Byzantines, is downplayed. The Byzantines, in this body of scholarship, are cast as the group felled by the Ottomans, rather than as a civilization in itself with which the Ottomans maintained a lively cultural, architectural, and social discourse. This sidelining of the Byzantines was practiced not only in studies of Bursa, but also in treatments of other Anatolian cities and of the Balkan cities later overtaken by the Ottomans. Yet a richer and more accurate narrative of the city and its Ottoman accommodation emerges when one taps alternative sources, such as visual and written records by travelers (focusing here on the seventeenth to the nineteenth centuries), as well as archaeological sources. Correspondingly, this project aims to explore what might be called the “stratigraphy of remembering,”⁹ the process by which impressive histories of Roman, late antique, and Byzantine civic and religious monuments were reused and embellished by the Ottomans. The intent will be to expand the picture of the period beyond a Turkish-centric focus on Ottoman arrival and hegemony.

Framing the Study Area: Before the GPR, from Prousa to Bursa

In his pioneering work *Christianity and Islam under the Sultans*, Frederick William Hasluck uses the term “architectural transference”¹⁰ to describe the idea of sanctity continuing from the Byzantine to the Ottoman periods, as demonstrated by the conversion of Byzantine buildings into mausolea and mosques in fourteenth-century Bursa. In fact, early Ottoman domination and the Islamic presence were more clearly expressed in the standard practice of transforming the main church

of a conquered city into a mosque,¹¹ as in the case of St. Sophia in Nicaea in 1331 and the Orhan mosque in Biga around the mid-fourteenth century. Prousa’s 1326 conquest represents something of an exception, in that no physical record exists of a cathedral having been converted to a mosque,¹² but two Byzantine churches were converted for use as the mausolea of Osman and Orhan, as discussed earlier in this report.

Just before Prousa fell to the Ottomans, Osman, the acknowledged founder of the Ottoman state, died and was buried in Söğüt in 1324. Orhan, his successor, had Osman’s remains brought to Bursa shortly after the conquest of the city, and the Ottoman founder was buried in a Byzantine religious building in the upper city—the legendary “Silver Dome” of a prominent religious complex called Manastır (Monastery, i.e., the Monastery of Prodomos) in Ottoman sources and travelers’ accounts.¹³ Texier’s¹⁴ drawing of this edifice has been discussed extensively in several previous publications, while illustrations by Cassas in 1786,¹⁵

11 S. Vryonis, *The Decline of Medieval Hellenism in Asia Minor and the Process of Islamization from the Eleventh through the Fifteenth Century* (Berkeley, 1971), 197–98 and n. 361. Vryonis mentions that Nicomedia and Amastris had converted mosques from churches following the Seljuk conquest. In Trigleia, the church of St. Stephanos (present-day Fatih Camii) is the only building that was converted into a mosque in 1560–61. S. Humphreys, *Islamic History: A Framework for Inquiry* (Princeton, 1991), 273–79, discusses patterns of conversion in Islamic contexts.

12 Though no archaeological evidence survives, several travelers, including Evliya Çelebi (*Seyahatname*, ed. F. İz [Istanbul, 1989], 2:9) and Ibn Baṭṭūṭa (*Seyahatname*, ed. M. Şerif [Istanbul, 1914], 1:341), state that Orhan built a mosque (Çelebi) or converted a Byzantine church (Battuta) in the upper city in the vicinity of the tombs. B. Menthon, *Une terre de légendes de Bithynie* (Paris, 1935), 45 and 48, gives a similar account. See also E. H. Ayverdi, *Istanbul mi’ârîsinin ilk devri* (Istanbul, 1966), 58; A. Gabriel, *Une capitale turque: Brousse-Bursa*, 2 vols. (Paris, 1958), 1:43–44; S. Eyice, “Bursa’da Osman ve Orhan Gazi Türbeleri,” *Vakıflar Dergisi* 5 (1963): 131–47.

13 Aşıkpaşazade (*Tevârih-i Al’i Osman*, ed. N. Atsız [Istanbul, 1949], 112) and Neşri (*Kitab-ı Cihan-Nüma*, ed. F. R. Unat and M. A. Köymen [Istanbul, 1945], 1:115) refer to Osman’s wish to be buried in this legendary silver-domed building.

14 C. F. Texier and P. Pullan, *Byzantine Architecture* (London, 1864), 157.

15 L. F. Cassas, *Voyage pittoresque de la Syrie, de la Phénicie, de la Palestine et de la Basse Égypte* (London, 1805); A. Pralong and J. P. Grélois, “Tombeau d’Orhan à Brousse,” in *Byzance Retrouvée: Érudits et voyageurs français*, ed. M.-F. Auzépy (Paris, 2001), 138–39, fig. 74.

9 For the use of this concept in visual studies, see K. J. Fewster, “The Role of Agency and Material Culture in Remembering and Forgetting: An Ethnoarchaeological Case Study from Central Spain,” *Journal of Mediterranean Archaeology* 20, no. 1 (2007): 89–114; as well as D. F. Ruggles, “The Stratigraphy of Forgetting: The Great Mosque of Cordoba and Its Contested Legacy,” in *Contested Cultural Heritage*, ed. H. Silverman (New York, 2011), 51–67.

10 F. W. Hasluck, *Christianity and Islam under the Sultans* (Cambridge, 1929), 6–8.

Löwenhielm in 1824–26,¹⁶ and Catenacci in 1835¹⁷ have come to light recently.

Results of the Fieldwork

Geophysical methods have lately proved their ability to enhance archaeological fieldwork. Because GPR in particular is a noninvasive technique that can produce profiles and maps of buried features and stratigraphic layers, it gives archaeologists an excellent strategic and planning tool. In this way, logic suggests it could be highly useful in dispelling myths about the transformation from Prousa to Bursa. And archaeological planning can be quite intricate in urban sites such as the Tophane area, given the complex mingling of ancient and recent structures, as well as their renovation over centuries.

Previous GPR Work in the Old City of Bursa

Limited geophysical survey work has previously been done in Bursa. In 2007, a survey was conducted by Professor Metin İlkışık, working with the municipality of Osmangazi. This survey used a 250 MHz antenna and looked for deeply buried features and geological layers. The radar frequencies used in this survey penetrated to about 5.5 meters. A cursory analysis of those data shows that, at about 3.5–5.5 meters, reflections were produced from a bedrock surface. Professor İlkışık's project found that older remains rested atop this bedrock layer at a depth of 0.7–3.5 meters. The 2007 survey also identified a fill of 1.5–2.0 meters, which the surveyors associated with recent construction, and they reported that the ancient remains began at 1.5 meters and continued down to the bedrock. They also noted that cables, pipes, and other modern utilities were predominantly located at a depth of 20–70 centimeters. The present survey supports this conclusion about modern utilities and their depths, with modern intrusions including cables and pipes. Yet, in addition,

important structural remains, mostly residential, were found closer to the surface.

The GPR Method: A Brief Introduction

The GPR method functions by measuring how long it takes for pulses of radar energy transmitted from a surface antenna and reflected from buried discontinuities to be received back at another surface antenna.¹⁸ When the paired antennas are moved along transects on the ground surface, two-dimensional profiles of buried stratigraphy can be produced by stacking many hundreds or thousands of reflections together to produce what are termed reflection profiles. Changes in the reflected wave strength (measured as amplitude variations) and the geometry of those reflections in profiles can then be related to the distribution and orientation of subsurface units and features of interest. These changes might be caused by stratigraphic layering, archaeological materials, anthropogenic soils or fill layers, or various other objects or biogenic disturbances in the ground.¹⁹ Many tens or sometimes hundreds of reflection profiles can then be collected in a grid and analyzed within a three-dimensional “cube” of reflection data to produce complex images of buried materials in ways not possible using other near-surface geophysical methods.

GPR is most effective at sites where artifacts and features of interest are within about 3 meters of the surface, but it has occasionally been used for more deeply buried deposits.²⁰ This depth of penetration and high degree of subsurface resolution make the method particularly applicable to urban Turkey, where a long history of habitation means that archaeological features can be both deeply buried and highly stratified.

For years, a growing community of archaeologists has been routinely incorporating GPR, as well as other near-surface geophysical methods.²¹ GPR maps and images can thus become primary data to guide the placement of excavations, or possibly to define sensitive areas containing cultural remains to preserve. Archaeological geophysicists have also used the GPR

16 K. Ådahl, ed., *C. G. Löwenhielm: Artist and Diplomat in Istanbul, 1824–1827* (Uppsala, 1993), 27; E. Yenal, ed., *Bir Zamanlar Türkiye—Turkey as It Was: Carl Gustaf Löwenhielm Bir İsveç Elçisinin 1820'lerdeki Türkiye Albümü—A Swedish Diplomat's Turkish Portfolio in the 1820's* (Istanbul, 2003), fig. 173.

17 A. Pralong and J. P. Grégoire, “Les monuments byzantins de la ville haute de Brousse,” in *La Bithynie au Moyen Âge: Géographie et habitat*, ed. B. Geyer and J. Lefort (Paris, 2003), 134–49, fig. 2.

18 L. B. Conyers, *Ground Penetrating Radar for Archaeology* (Walnut Creek, CA, 2004), 62.

19 Ibid., 148.

20 Ibid., 16.

21 Ibid., and C. Gaffney and J. Gater, *Revealing the Buried Past: Geophysics for Archaeologists* (Stroud, 2003).

method as a way to place archaeological sites within a broader environmental context, to test working hypotheses regarding past cultures, and to study human interaction with, and adaptation to, ancient landscapes.²² The success of GPR surveys depends to a great extent on soil and sediment mineralogy, clay content, ground moisture, depth of burial, surface topography, and vegetation. This geophysical method cannot be applied immediately to just any subsurface problem, but with thoughtful modifications in acquisition and data processing, GPR methods can be adapted to many different site conditions.

Tophane Area GPR Surveys: Information on Software and Antennas

In all tests, the Geophysical Survey Systems Inc. (GSSI) Subsurface Interface Radar System model 3000 (SIR-3000) was used to collect the GPR data, with a survey wheel used to place reflections in space along survey transects. The 400 MHz antennas were used in all tests. Reflection data were transferred to a laptop computer and processed using software. This software allowed reflection profiles to be viewed and analyzed for effective depth penetration, and at some sites grids of closely spaced profiles were used to produce amplitude maps of buried features of interest (fig. 2).

Data Processing Procedures

The raw reflection data collected by GPR consist of an amalgam of many individual traces along two-dimensional transects within a grid. Each reflection trace contains a series of waves that vary in amplitude depending on the amount and intensity of energy reflection that occurred at buried interfaces. When these traces are plotted sequentially in standard two-dimensional profiles, the specific amplitudes within individual traces that contain important reflection information are sometimes difficult to visualize and interpret. Rarely is the standard interpretation of GPR data, which consists of viewing each profile and then mapping important

22 L. Conyers and T. Osborne, "GPR Mapping to Test Anthropological Hypotheses: A Study from Comb Wash, Utah, American Southwest," in *Proceedings of the 11th International Conference on Ground-penetrating Radar*, ed. J. J. Daniel (Columbus, OH, 2006), 1–8; K. Kvamme, "Geophysical Surveys as Landscape Archaeology," *American Antiquity* 68 (2003): 435–57.

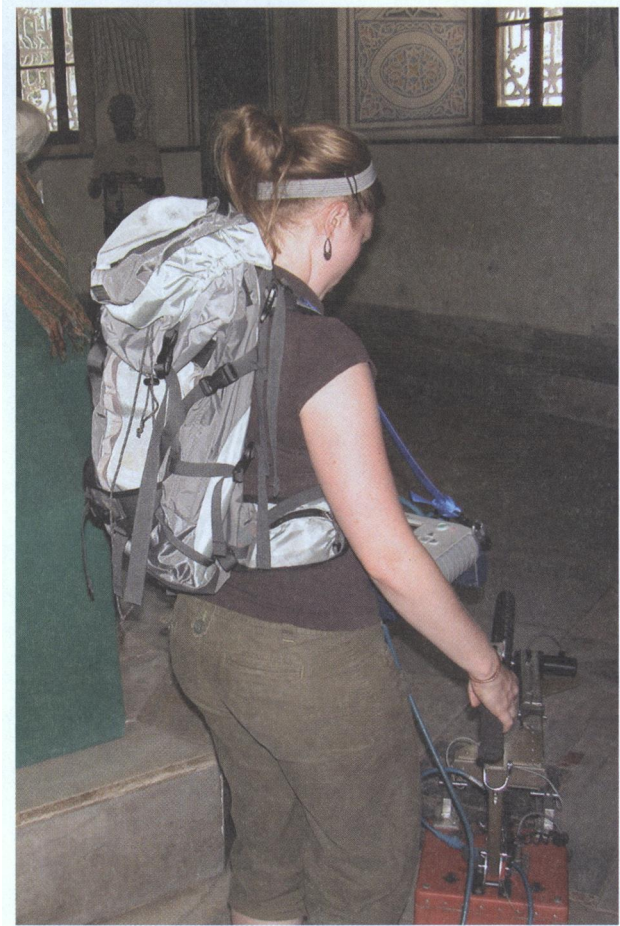


FIG. 2. Setting up of the antenna, computer, and the wheel (photo by Suna Çağaptay)

reflections and other anomalies, sufficient, especially when the buried features and stratigraphy are complex. For this reason, amplitude analysis must be used.

An analysis of the spatial distribution of the amplitudes of reflected waves is important because it indicates subsurface changes in lithology and other physical properties of the ground. The higher the contrasting velocity at a buried interface, the greater the amplitude of the reflected wave from a surface or point-source object. If amplitude changes can be related to important buried features and stratigraphy, the location of higher or lower amplitudes at specific depths can be used to reconstruct the subsurface in three dimensions. Areas of low-amplitude waves indicate uniform matrix material or weathered and homogenized A and B soil horizons, while those of high amplitude denote areas of high subsurface contrast,

such as buried archaeological features or possible floor features. In order to be correctly interpreted, amplitude differences must be analyzed in discrete slices that examine only the strength of reflections within specific depths in the ground. Each slice consists of the spatial distribution of all reflected wave amplitudes at various depths, which are indicative of these changes in sediments, soils, and buried materials.

Amplitude slices were constructed parallel to the ground surface in equal time intervals a.k.a. two-way travel time (TWT)—of five nanoseconds. Each five-nanosecond slice then became analogous to mapping of about thirty centimeters in thickness (using the velocity of about 5 cm/ns), as with arbitrary elevation levels in standard archaeological excavations. For the Tophane project, the top slice maps were not analyzed because they contained primarily modern disturbances, such as pipes, and the historic features of interest were not distinguishable. The working assumption was also that Byzantine features would not be found in the top 30–60 centimeters of soil.

To compute horizontal amplitude slices, the computer compares amplitude variations within traces that were recorded within defined time windows. When this is done, both positive and negative amplitudes of reflections are compared to the norm of all amplitudes within those windows. No differentiation is usually made between positive or negative amplitudes in these analyses; only the magnitude of amplitude deviation from the norm is considered. Low amplitude variations within any one slice denote little subsurface reflection and therefore indicate fairly homogeneous underlying material. High amplitudes indicate significant subsurface discontinuities, detecting in many cases buried features that produced strong reflections at the boundary between the two (in this case, stones or possible floors or walls). An abrupt change between an area of low and high amplitude can be very significant and may indicate a major buried interface between two media. Degrees of amplitude variation in each time slice are assigned arbitrary colors along a scale. Usually, no specific amplitude units are assigned to these color or tonal changes. In all subsequent maps, a spectrum of color has been used in the amplitude maps, with red being highest amplitude (presence of rocks or hard surfaces) and blue and white indicating homogeneous soils. Many of the grids collected are not of uniform rectangular shape. When the computer processes these grids, the areas of

missing data are filled in by the program. These areas of the map appear as light blue or white and indicate the missing data.

When interesting high-amplitude features show up in slice maps, this signals the need to go back and look at the individual profiles to confirm what these features might be, and to study their appearance in profile. When significant features are visible in both map form and profile, those will be shown as figures in the discussion of each GPR data grid.

Results from the Tophane Area GPR Survey 2009

Grid 4

Grid 4 data were collected in a grassy area almost directly east of Grid 3 and west of the large clock tower located in the center of Tophane Park. This is a highly complex grid that shows evidence of many intersecting walls. Byzantine and Roman walls tend to range from 0.5 to 2.0 meters in thickness, which creates strong reflections in GPR maps. There are several reflections in the amplitude slice maps that appear to be two closely spaced walls, but are actually edges of the same walls. The angle of the radar created high-amplitude reflections off the denser edges of the walls, while the interior wall did not create a strong reflection. This results in an image of two wall lines indicating a single line.

Another important feature evident in Grid 4 is a buried horizon at 60 centimeters depth. This horizon perhaps corresponds to the earthquake level, where the ground was leveled and debris buried. One difficulty in analyzing these grids has been to determine which features may date to the Byzantine period and which are later constructions. It seems likely that features below this 10 ns horizon fall within the desired time range in which features of interest might be found, as they are below the earthquake horizon. However, in some areas this horizon has been truncated by more recent disturbances, such as utility burial, and it is more difficult to date the features.

In the 0.6–0.9 m slice, only one wall is visible, short and running north–south at 0 m E (see fig. 4). This wall expands in the following slice and becomes part of a small structure about 5 × 6 m in size. By the 1.2–1.5 m amplitude map, a strong wall reflection has developed at 7.5 m N, which runs the length of the grid.

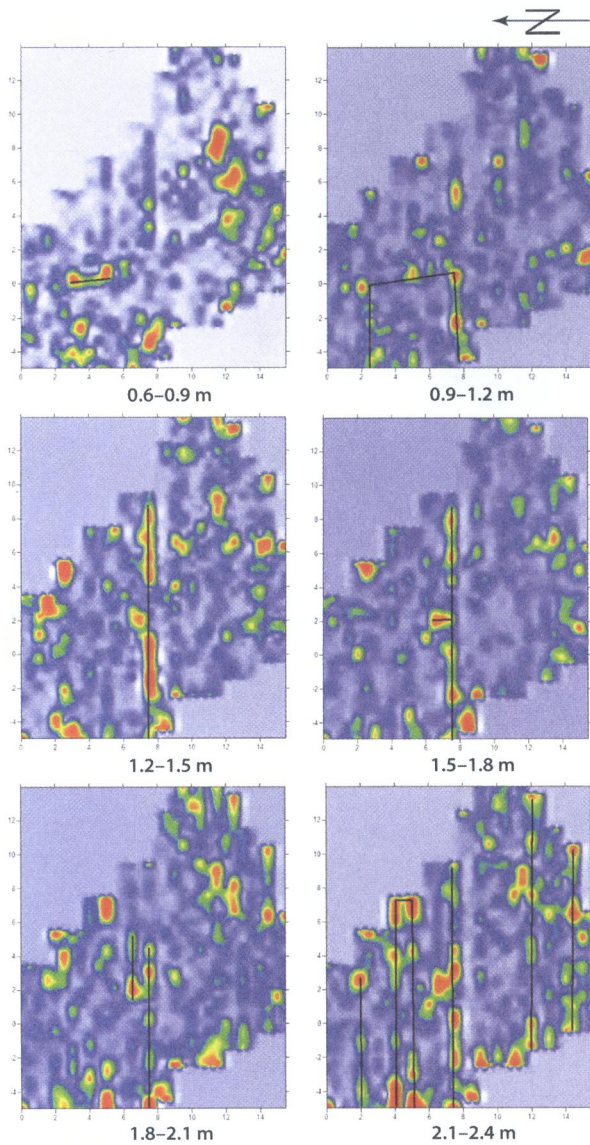


FIG. 3. Amplitude slice map of Grid 4. This image shows a range of walls, which are shown by the black lines drawn across the grid. These walls were picked up strongly by the radar, which was run directly along them.

This wall is visible in all the following maps, and in the 1.8–2.1 m slice map it appears as a double-line reflection. This indicates that the wall is approximately 1 m in width. In the 1.5–1.8 m map, a short intersecting wall running north–south is visible at 2 m E. The 2.1–2.4 m amplitude map is the most complicated. There are walls running east–west visible at 2 m, 4–5 m, 7.5 m, 12 m, and 14.5 m. The reflection at 4–5 m is another wall approximately 1 m wide. Reflections are visible from

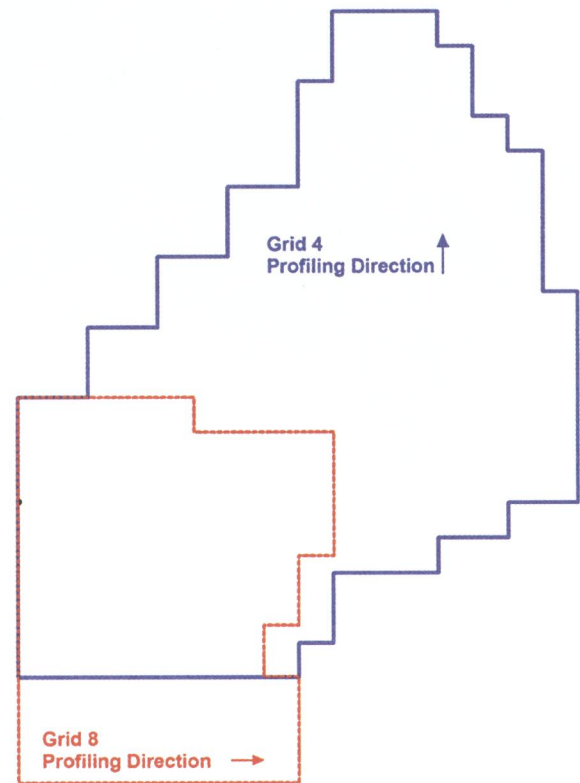


FIG. 4. Illustration showing relationship of Grid 4 and Grid 8

both edges of the wall, creating the visual impression of two tightly spaced parallel walls.

Grid 4 is highly complex, holding great potential for understanding the park's architectural history. A majority of the visible walls run E–W and only a few smaller walls run N–S. This may have some significance. The wall reflections are also strong and the walls are wide, ranging from 0.5 to 1.0 m or more in width. Byzantine wall construction is also within this range.

Grid 8

Grid 8 is included here because it is a re-collection of a portion of Grid 4 profiling in the x direction. Figure 5 shows the relationship of the two grids and their relative profiling directions.

Grid 8 provides little more data than was previously available in Grid 4. It does expand the length of the walls visible in Grid 4 at 2 m, 4 m, and 8 m N–S. The wall visible at 0 m E is also more visible, and in the 27–32 ns slice it develops into a double-line wall, indicating that the wall is about 1 m wide.

FIG. 5.
Amplitude map of Grid 8

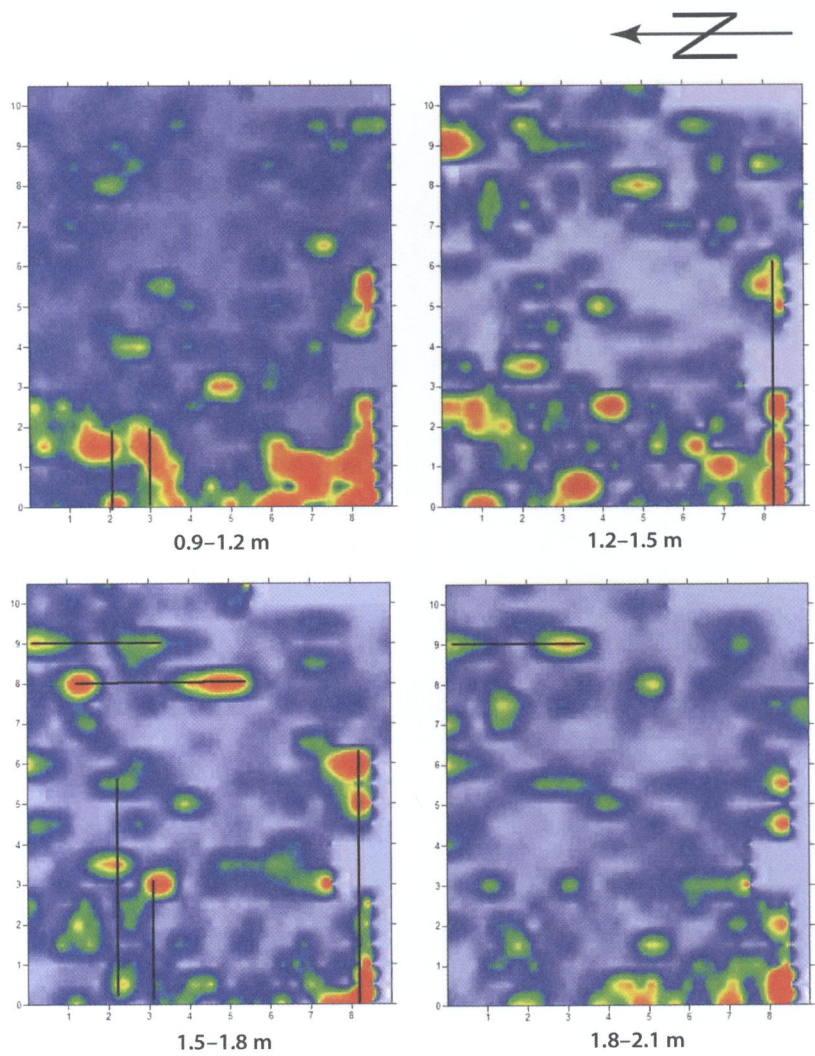
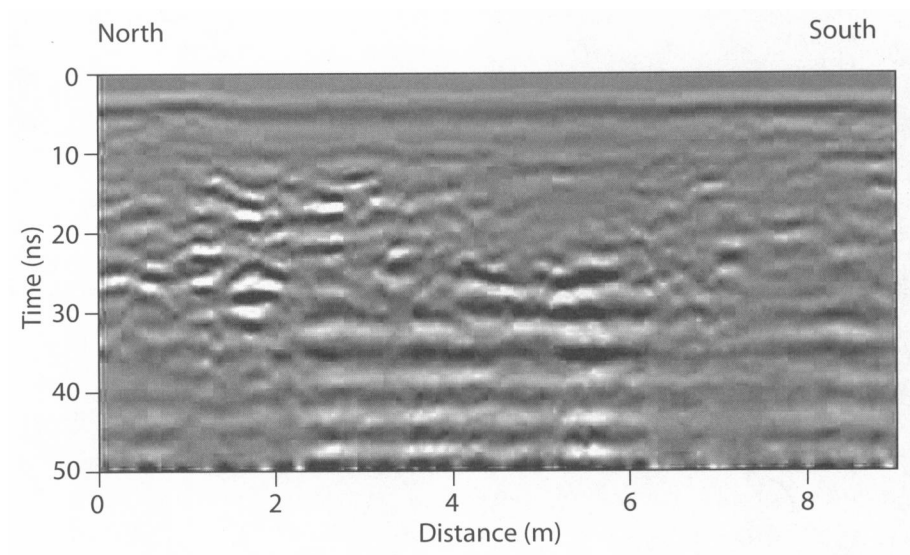


FIG. 6.
Reflection profile 17, running
along the top of the wall visible
at 8–9 m E. At 2 m in the profile,
one can see the N-S wall visible in
the amplitude maps at 2 m.



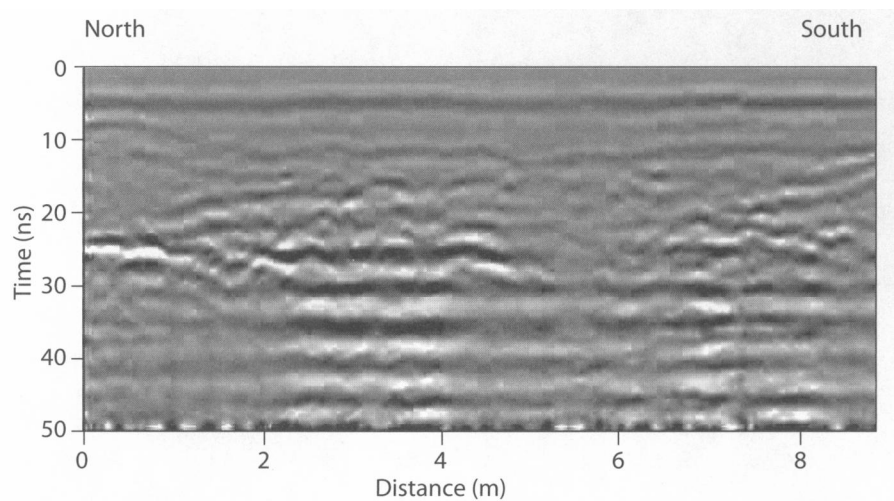


FIG. 7. Reflection profile 19, showing the second reflection generated by the wall at 8–9 m E

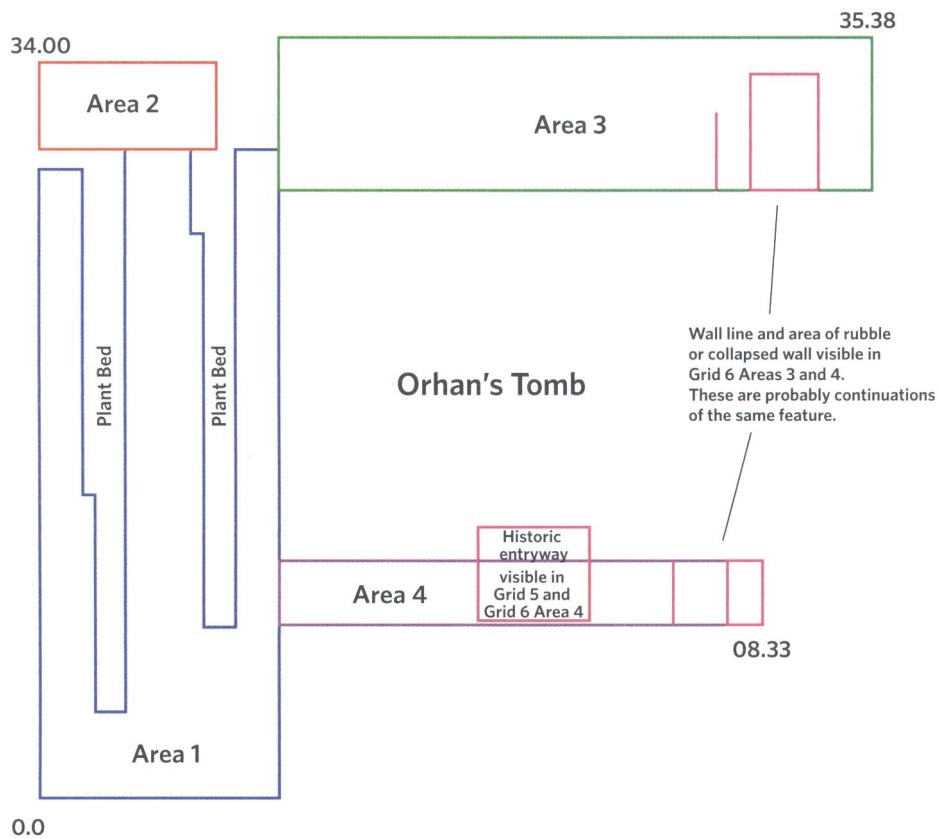


FIG. 8. Annotated map of Grid 6, showing the location of walls and other features that extended through multiple areas of the grid.

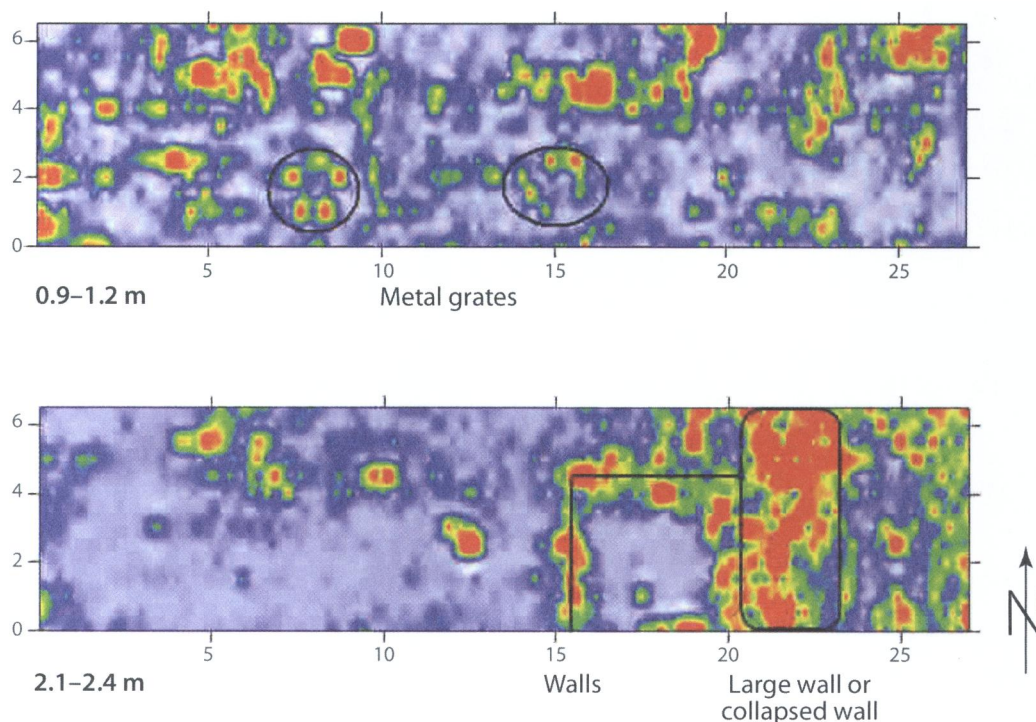
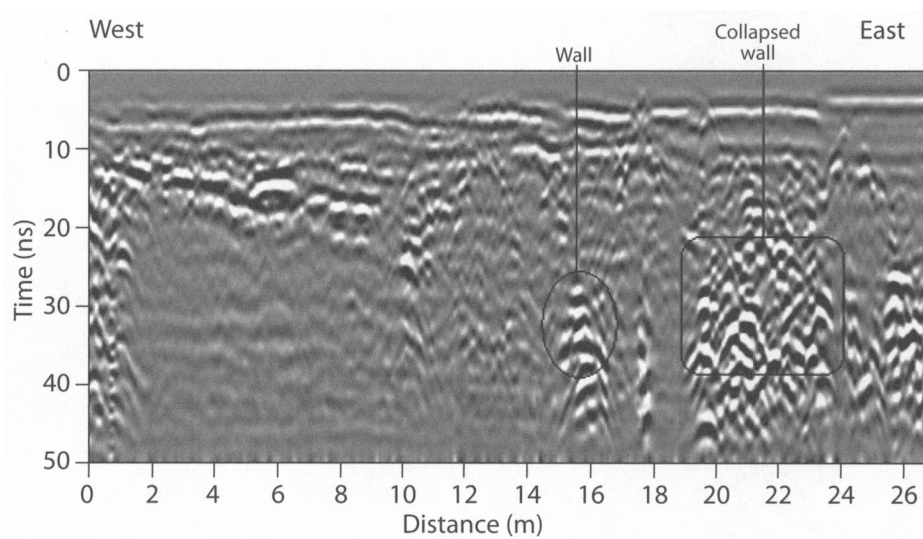


FIG. 9. Amplitude slice map of Grid 6, Area 3. The upper slice map at 0.9–1.2 m depth shows the location of two metal grates visible on the surface. The lower map at 2.1–2.4 m shows the location of three interconnected walls. The wall at $x = 15.5$ lines up with a wall visible in Area 4. The area of wall at $x = 21$ also lines up with Area 4 (see fig. 10). This suggests that these are larger walls that run under Osman's Tomb and are part of an earlier structure. There is a third wall segment at $y = 4$ that is a shorter connecting wall.

FIG. 10. Reflection profile 34 (Grid 6, Area 3). The wall segments are visible in the slice maps at $x = 15.5$ and $x = 21$. These are the walls that are also visible in Area 4.



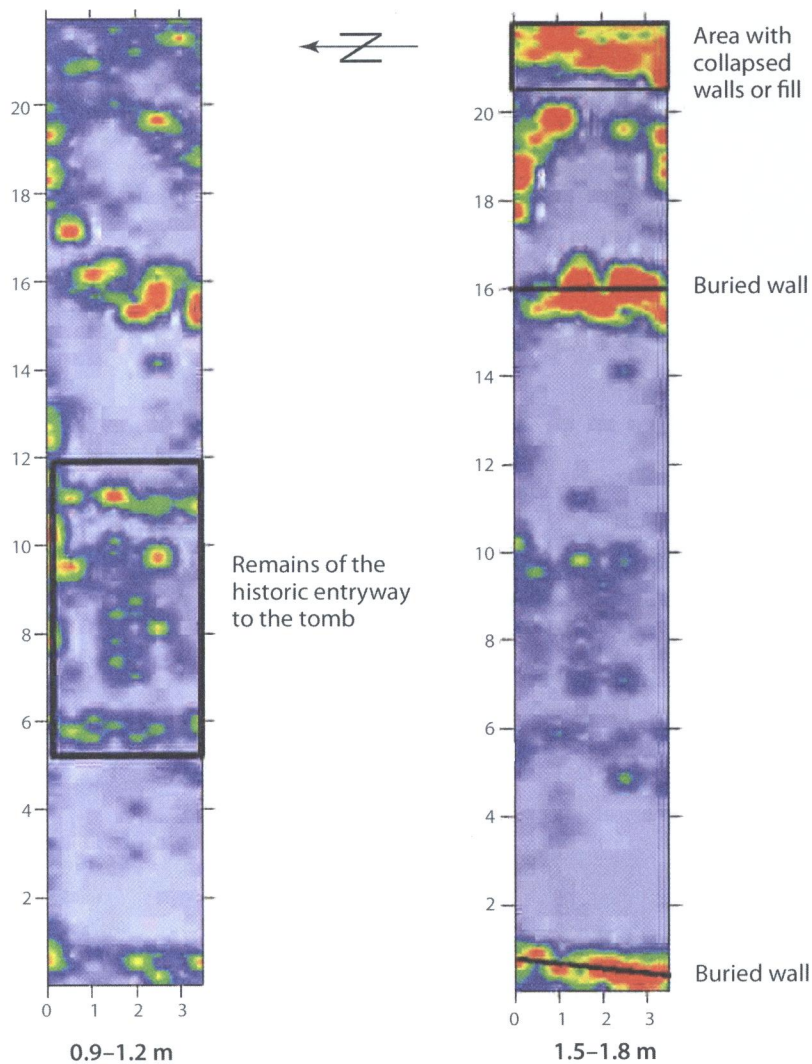


FIG. 11.

Amplitude slice maps of Grid 6, Area 4, in front of Orhan's Tomb. In the upper slices the remains of an entryway can be seen between $x = 6-11$. This entryway can be seen in historic photographs, and the original marble floor is visible on the surface. In the second slice map, two walls and an area of wall fall or fill is visible.

Grid 6

Grid 6 is actually composed of four different areas that surround Orhan's Tomb. All four areas were collected using the same parameters so that the grids could be compared visually.

It was hoped that these grids would reveal remnants of the structures destroyed in the earthquake. Indeed, the verdict is still out. The area has been extensively landscaped, both during the reconstruction of the tombs and during subsequent remodeling.

Areas 3 and 4, located to the north and south of Orhan's Tomb, show the most potential for understanding the architectural history of the area immediately

surrounding the tombs. In Area 4, not only was the historic entryway to the tomb visible, but two wall segments and an area that seems to contain wall rubble were visible. The wall segments visible in Area 4 continue to run north and are also visible in Area 3. These are the remnants of earlier constructions; though their date cannot be currently determined, they could be Byzantine. However, the curvature and thickness of the walls in Areas 3 and 4 look as if they are conjoined and form a line of an apsidal wall on the east, which might be attributed to the east wall of the main church in the monastery of Prodromos, which housed Orhan's remains.

Further investigations of these wall segments through small excavations would be of interest.

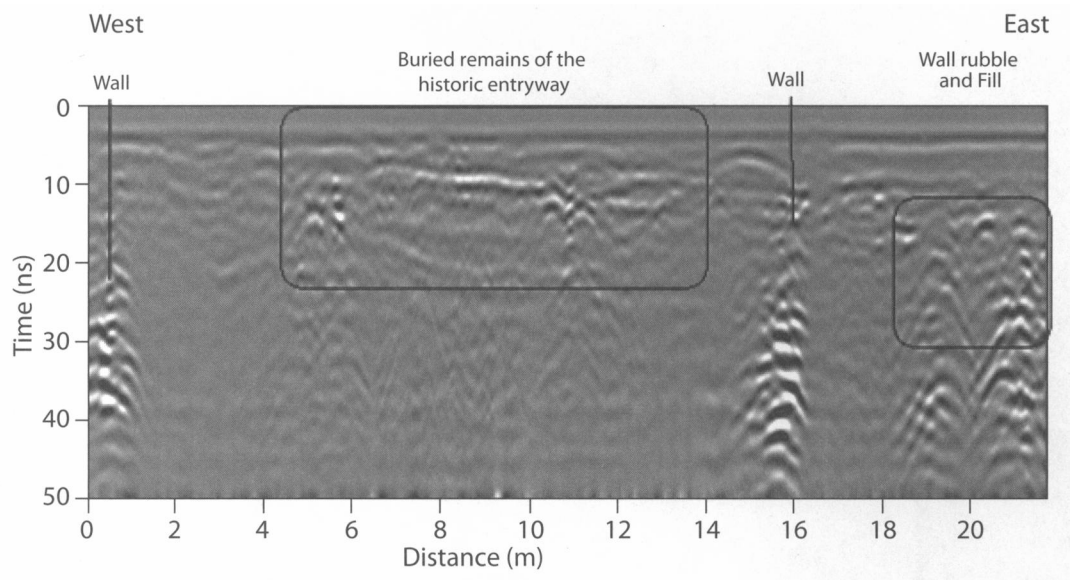
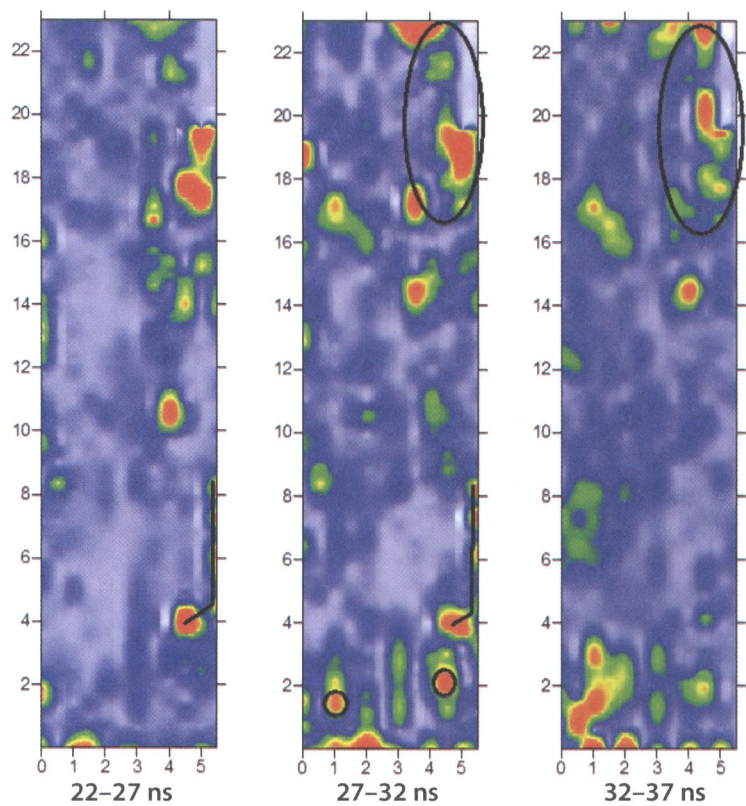


FIG. 12.
Reflection profile 52 (Grid 6, Area 4). Two buried walls and the area of wall fall and debris are evident at the east end of the grid. In the center of the profile the remains of the historic entryway are visible. On either edge, one can see the remains of the walls; in the center is the reflection from the floor, which is still visible on the surface. Below the feature and to the east, one can see a depression, presumably from the construction of the entryway.

FIG. 13.
Amplitude maps of Grid 9, showing several architectural features. Running along the east side of the maps between 4–9 m, there is a wall segment. Along the southern edge of the grid around 2 m N, there are several wall reflections. These do not appear as a continuous wall in either the reflection profiles or amplitude maps. There may at one time have been a continuous wall, but that cannot be determined from these data. Finally, along the north end of the grid between 14–22 m N-S, there is an area of rubble that may also contain a deeply buried or fragmented wall, although this is difficult to determine.



Military Guesthouse

The area of the military guesthouse has undergone almost constant construction since the Byzantine period, as evidenced both in the GPR maps and in historic photographs, which show a range of historic buildings that are no longer standing. Since this is a residential area, it also has a large number of pipes and other non-architectural subsurface features.

Due to the quantity of modern features observed, they are neither discussed nor noted unless they are significant in the appearance of the grid and could interfere with the interpretation of the data of interest.

The constant addition of subsurface features has made determining what features are Byzantine very difficult. The 10 ns earthquake layer is truncated throughout all the grids collected in the military guesthouse. The features lying within these more recently disturbed areas are likely recent but could be Byzantine. There is no way to determine their date from the data available. The grids in the military guesthouse have been drawn in on a paper map showing their location; however, more specific information needs to be obtained to determine these grids' depth.

Grid 9

Grid 9, the first grid collected inside the military guesthouse, is just west of the military office (Building #028) on a flat paving-stone surface. To the west and south of the grid, a metal grate ran along its length.

The areas of interest in this grid are along its east edge, near where maps indicate the original Byzantine defensive walls were situated. A wall seems to run along the east edge, visible in two places, and seems to bend at the south edge. A separate wall appears along the south edge of the grid, although this seems to have been disturbed at some point and is no longer a consecutive wall line but several smaller wall segments. Finally, an area of architectural debris is visible along the north end of the grid, which may contain a wall segment.

Grid 14

Grid 14 occupies the parking and driveway area in front of the main military building (#4). The shape of the grid was determined by the lot's general shape, the locations of parked cars, and a large tree at 15–20 m N–S.

Only one amplitude map is shown for Grid 14 because the features visible in the grid remained consistent throughout or disappeared entirely in deeper maps. This image gives a clear picture of all the features present in this grid.

Two walls are clearly visible, one at 4 m E–W and the other at 12 m N–S. A third wall and possible surface are located along the north edge of the grid at 0.5–1.5 m.

Grid 14 contains several interesting features and definitely constitutes an area for further research. The walls visible in the grid look as though they might have

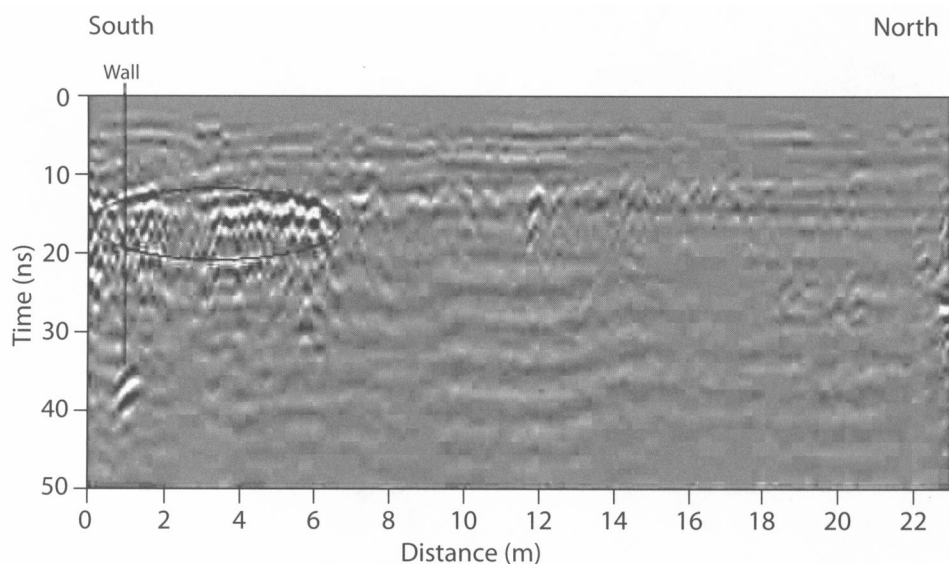


FIG. 14. Reflection profile 6 (Grid 9). At $x = 3$ m a deeply buried wall at the north end of the grid is seen. On top of that architectural feature is a more recent layer that appears to be composed of a metal mesh. This is also visible in reflection profile 7.

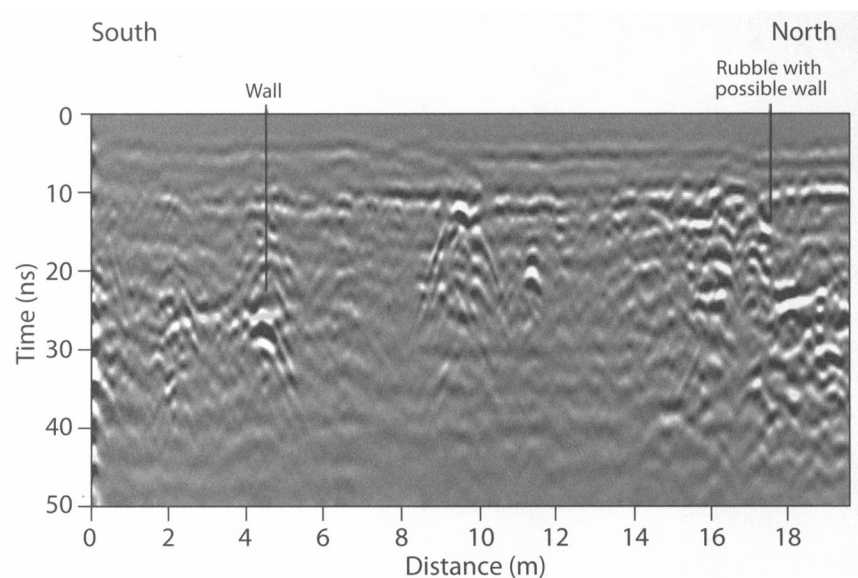


FIG. 15.
Reflection profile 11 (Grid 9).
At $x = 5.5$ m a wall at 4 m runs
E-W along the grid. At the
north end of the profile, one
can see the area of architectural
rubble with a possible wall.

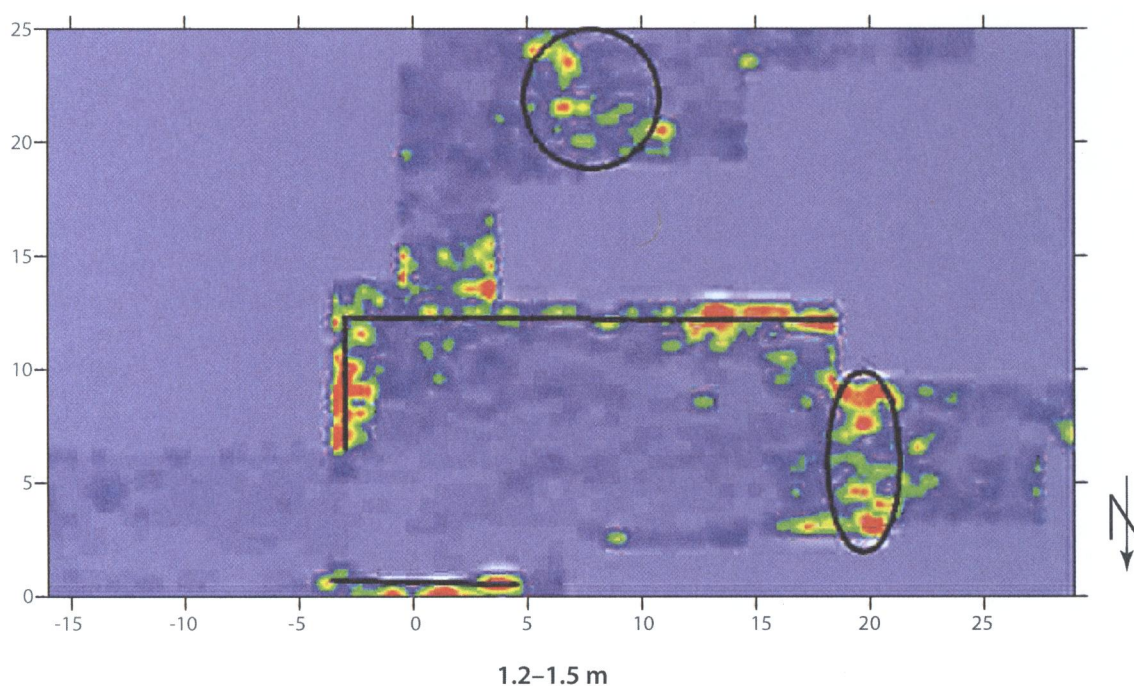


Fig. 16. Amplitude slice map of Grid 14

been connected as part of an earlier building. This could be confirmed through excavations. It would be interesting to identify the feature visible in reflection profile 41 and how this area of the grid connects and relates to the apparent building, which is visible in the grid's north half. This might be a building of residential function, with multiple phases dating to the Byzantine and Ottoman periods.

Framing the Study Area: In the Aftermath of the 2009 GPR Survey, Plans for the Future

If granted a permit, an international team of scholars and students will excavate in summer 2015 at the points where GPR revealed exciting results, such as the buildings of a religious complex with superimposed

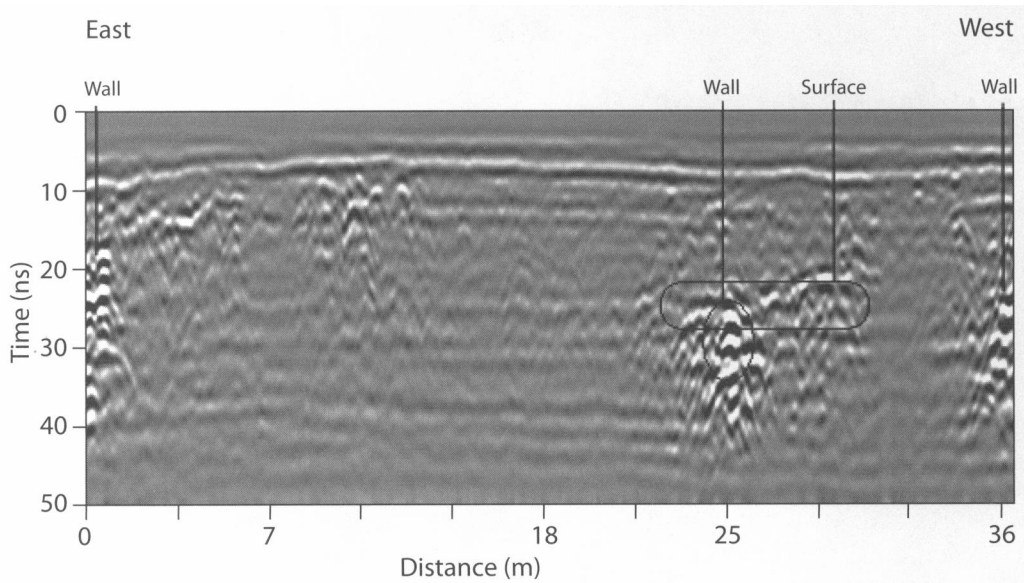


FIG. 17. Reflection profile 15 (Grid 14). At $y = 7.5$ in the amplitude map, the location of the walls is visible in the horizontal slice map at $x = 0, 20$, and 29 . The reflection at $x = 20$ also shows a surface that is visible in the slice maps.

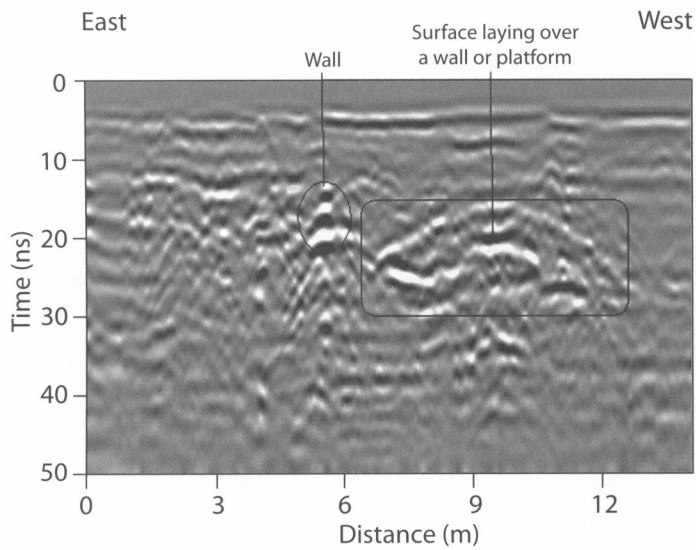


FIG. 18
Reflection profile 41 (Grid 14).
At $y = 20.5$, the rubble is visible
in the slice maps at $y = 20-25$, $x =$
 $5-15$. Here, one can see that there
is a distinct wall segment and what
appears to be a platform or other
surface buried under a second
surface.

layers in Grids 4 and 8, and the wall remains of what is possibly the pre-earthquake phase (perhaps the *katholikon* of the Prodromos monastery) of the Tomb of Orhan in Grid 9, as well as the remains of the palace quarters in Grid 14. The subsequent plan will be to create an archaeological park, leveraging the insights of a group of scholars, practitioners, and students of diverse backgrounds at Bahçeşehir University's School of Architecture and Design and School of Communications and Media. Participants will engage in the continuing work of sorting through the layers and dispelling myths associated with the making of the first Ottoman capital. In the context of this project, one team consisting of four members will carry out detailed excavations and another of eight will focus on integrating what is now above ground at the Tophane area with the layers to be excavated.

The site, once finished, is intended to have walkways that would allow visitors to see both the excavated areas and the presently standing buildings. Information panels and galleries will display the findings from the excavations and related historical material. Few such archaeological parks exist today in Turkey—and none

in Bursa—so the hope is that this project sets an example. The city's archaeologically recovered urban fabric would constitute not only a new layer in Turkey's historical memory but also a legacy to be preserved for coming generations.

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